

# Precision Measurement of the $\mu$ p Capture Rate in a Hydrogen TPC

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Nuclear muon capture  $\mu + p \rightarrow n + \nu_\mu$  is a fundamental electroweak charged-current reaction. The capture rate is sensitive to the weak form-factors of the nucleon, in particular to the induced pseudoscalar coupling constant  $g_p$ . Its measurement would rigorously test precise predictions<sup>1</sup> of modern effective field theories based on the chiral symmetry breaking of low energy QCD. In spite of considerable effort, the experimental situation concerning this basic process is rather confused.

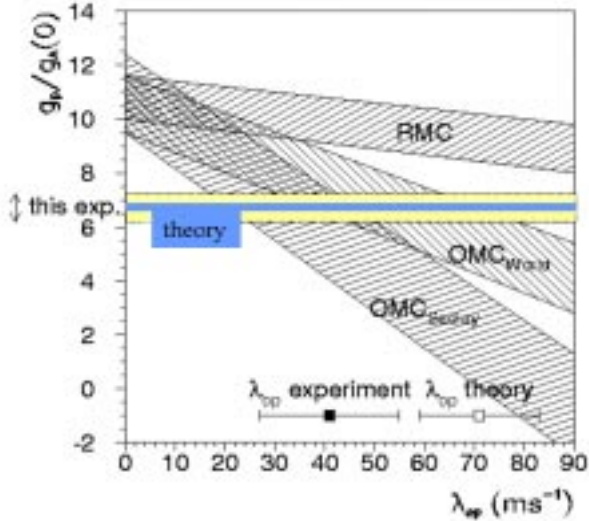


Fig.1: Current constraints on  $g_p$  from ordinary (OMC) and radiative (RMC) muon capture. OMC experiments suffer from limited precision and ambiguous interpretations due to the dependence on poorly known molecular parameters ( $\lambda_{op}$ ), while the recent RMC experiment deviates by  $4\sigma$  from theory.

A substantial improvement in precision (*this exp.* in fig.1) and independence from molecular parameters will be achieved by a  $\mu^-$  lifetime measurement in  $H_2$  gas with accuracy  $10^{-5}$ . It is based on a new technique with an ultra-pure hydrogen TPC. The small branching ratio for muon capture will be deduced by comparing this measurement with the lifetime of the free muon.

In fall 1998 a first engineering and test run was performed with a full scale TPC/MWPC detector

(partially equipped), which demonstrated the basic operation of the system with muons and electrons. The TPC is surrounded with MWPC's to localize entry and exit points and is filled with 10 bar of hydrogen gas. The idea of using a TPC is to unambiguously identify tracks of stopping muons and their decay electrons without using global pile-up rejection. Eventually this method will allow us to reach more than 10 fold higher beam rates than previous efforts and to achieve the required high statistical accuracy.

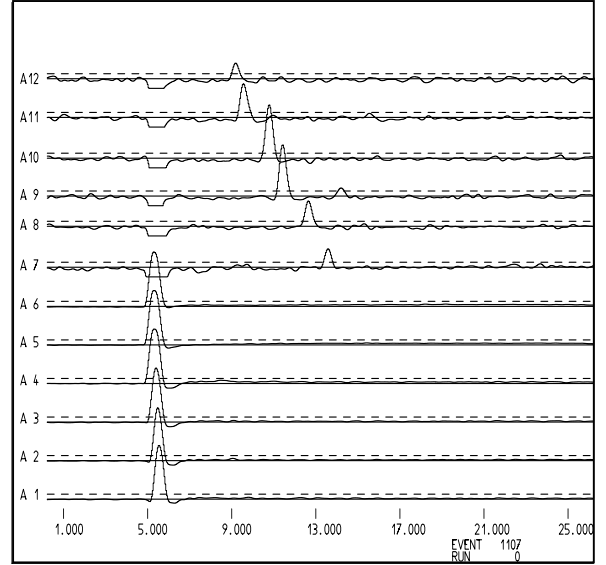


Figure 2 shows an event from our first test run in December 98. The muon can be seen passing the entrance wire chambers and stopping with large energy loss on anode 6 (time scale in  $\mu$ s, muon signals are scaled down). The decay electron is seen on anodes 7-12 going to the upper left, where it then exits the TPC and hits external wire chambers.

## Footnotes and References

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1. V. Bernard et al., Phys.Rev. D50 (1994) 6899;  
H.W. Fearing et al, Phys. Rev. D56 (1997) 1783